Effects of Climate Change, Glacial Retreat, and Snowfield Loss on Habitat Condition and the Affect on Wild Sheep Populations and Distribution in Polar and High Mountain Ecosystems in Alaska and Mid-Asia – A Comparative Study

USGS

Collaborative effort involving the USGS, New Mexico State University, University of Alaska Fairbanks, Foundation for North American Wild Sheep, International Sheep Hunters Association, and host countries.

USGS

Research Staff

Dr. Raul Valdez, New Mexico State University (Biologist)

Dr. Paul Geissler, U.S. Geological Survey (Glaciologist)

Dr. Bradley Reed, U.S. Geological Survey (Research Geographer)

Dr. Wayne Heimer, Alaska Fish and Game Department (retired - Biologist)

Raymond Lee, Foundation for North American Wild Sheep
(President/Biologist) International Sheep Hunters Association (President)

Dr. Craig Gerlach, University of Alaska, Fairbanks (Anthropologist)

Barry Middleton, U.S. Geological Survey (Geographer)

Amy Mathie, U.S. Geological Survey (Geographer)

USGS

Objective and Purpose

- To study, analyze, and model the long term effects of glacial and permanent snowfield retreat on wild sheep populations, phenology, habitat health, and carrying capacity in selected study areas in Alaska and Mid-Asia.

- The purpose of this research is to produce a set of management tools to be used by the State of Alaska, and collaborating international countries, such as Kazakhstan, Mongolia, Tajikistan, and Pakistan, in the development of sustainable habitat and wildlife management plans.

- This activity is intended to be a 3- 5 year effort beginning in spring 2007.

USGS

Statement of Problem

Wild sheep often experience large fluctuations in population dynamics, often from undetermined or undocumented causes.

Many studies of wild sheep populations have been completed, particularly in Alaska, but these studies are often dated and typically did not use remotely sensed data for evaluation of landscape change, vegetation change, and landscape dynamics related to glacial retreat over decades.

Even though previous wild sheep research has not focused on the use of remotely sensed data to determine glacial and snowfield recession, phenological changes, and the potential for changes in population dynamics and favoured habitat, the results of those previous research efforts will be utilized in the study.

Concerns about the effects of global warming are generally framed in the negative context. Wild sheep may represent an exception to this general concern. Without purposeful study, we will never know, and potentially beneficial management strategies and options associated with climate changes will remain unexplored.

USGS

Approach and Strategy

- The study will take a detailed multi-decade look at glacial retreat and loss of historic snowfields and resulting land cover and land use change in selected study areas in Alaska and Mid-Asia.

- A variety of remotely sensed data, ground-based observations, and existing historic databases will serve as the primary source of information to derive glacier and snowfield land cover. Satellite-based data include: Corona (1960's), Landsat selected dates for each decade from the 1970's onward), Aster (back to 1999), and very high-resolution satellite imagery such as Quickbird (for high intensity study sites).

USGS

• Exact study dates will be determined after evaluation of available imagery for suitability such as cloud cover. It is essential that areas of interest remains clearly visible and as cloud free as possible while still maintaining seasonal integrity.

• Historical glacial data collected by the GLIMS (Global Land Ice Measurements from Space) project and housed in the GLIMS database will also be used to identify past changes in glacial margins and extent of permanent snowfield.

• Ancillary data such as aerial photography (U.S. and Russian), USGS and Russian topographic maps, and historic exploration reports will be used for interpretation. A literature search will also be undertaken to identify historic maps of the study areas that go back as far as possible, hopefully to 1900 and beyond in an attempt to identify glacial margins and snowfield extent during that period that can be integrated into the baseline dataset.

USGS

• MODIS data will be integrated into the study to analyze phenological change at very high temporal resolution, along with visual observations, both historic and current, of general habitat health and favoured habitat of wild sheep populations.

•Current and historic data exists within the study areas for animal locations derived from radio collar, GPS, or manually recorded points resulting from visual sighting of wild sheep.

• Animal location data will be coupled with information derived from various satellite data and other datasets to construct models of habitat preference and changes by applying various classification and statistical methods (e.g., Wallace 2002, Huete et al. 2002, and Valdez 1982).

•Models will be developed to predict future phenological and habitat change and effects on wild sheep and goat populations.

USGS

• **Comparisons will be made between mid-Asian and Alaskan landscape changes and impacts on wild sheep and goat populations and preferred habitat.**

• **We hypothesize that climatic changes that are resulting in the retreat of glaciers and reductions in historically permanent snowfields are altering the traditional favoured habitat for high mountain large mammals, particularly wild sheep and goats.**

USGS

Questions and Issues

- **What is the rate of loss of glacial and permanent snowfield in the study areas and what would be the model for future recession based on historic and current rates.**
- **As potentially new habitat is opened up, what is the time period before it becomes "suitable" habitat for wild sheep and goats.**
- **As new habitat is created, do the sheep move into the new habitat quickly or over an extended period.**
- **Do whole populations move "up" to the new habitat, or slowly drift into and populate the new area, or do they essentially stay where they have traditionally grazed.**
- **Due to reduction in ice and snow are sheep and goats more or less susceptible to predation. Is there less escape terrain.**

USGS

- **What, if any, is the effect on lamb production and survival.**
- **Will changes in the habitat coupled with aboriginal hunting and/or licensed hunting and poaching (particularly poaching in Asia) effect populations, will populations increase/decrease/stay the same.**
- **What changes in domestic grazing will occur (in Asia). Will domestic herds be grazed in the newly emerging habitat, or will they remain in their traditional grazing areas.**
- **In Alaska, What, if any, is the effect of weather patterns – La Nina/El Nino on wild sheep populations and favored habitat.**

USGS

- What phenological, ecological and productivity changes are occurring in the vegetation of the glacial margin areas, and are they accelerating?

- How are the areas of habitat utilized by the sheep and goat populations changing, and is this change resulting in the creation of new habitat types, or simply the re-distribution of existing ones?

- Can the changing phenological and productivity characteristics of the vegetation in these alpine regions be reliably measured and monitored by the use of remotely sensed imagery (such as MODIS)? At what spatial and temporal resolution does information become most useful in these marginal areas?

- What is the best data and methodology to monitor habitat changes in these high-latitude, alpine areas going forward? Do we need to set up controlled study sites in these areas to maximize the science, and how would we proceed internationally?

USGS

•Are the on-going climate changes affecting both the permafrost and glacial ice melting rates equally, and are they coupled? In other words, does the retreat in glacier and ice field margins have an impact on the rate of permafrost melting beyond the warming temperatures (for example, from increased runoff entering the water table or warming/cooling the surface)?

USGS